An Industry Perspective Of Integrated Modular Avionics

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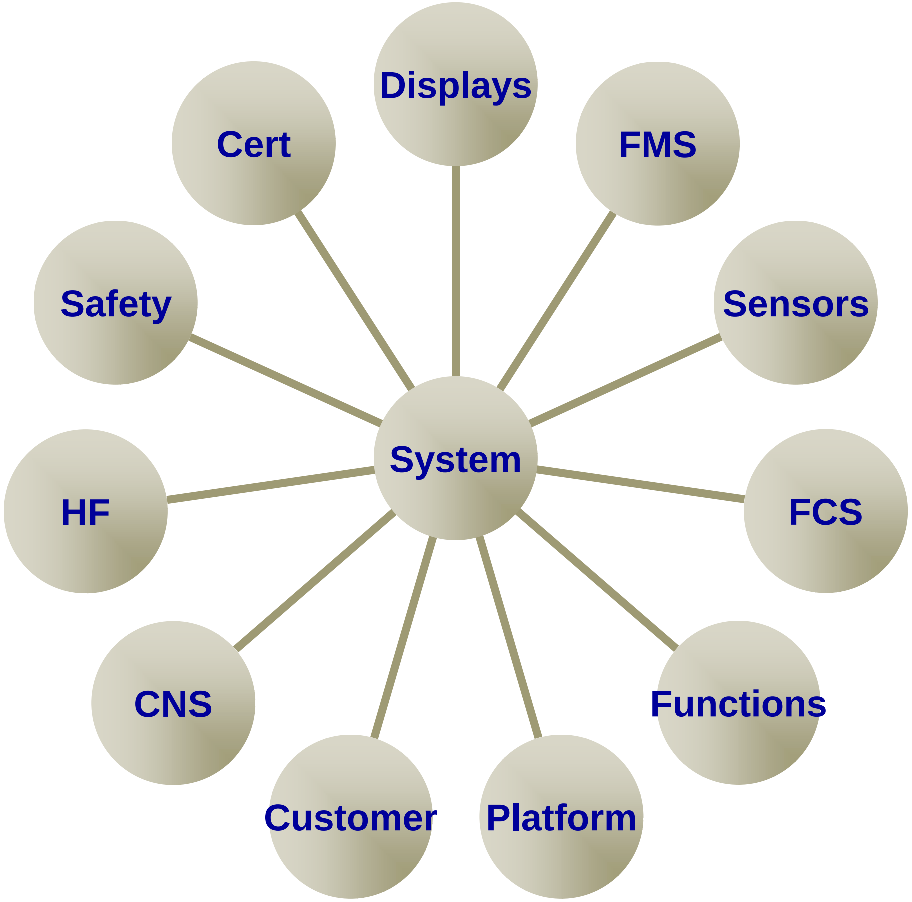
Content

- System design
- Reuse
- Integrated modular avionics
- Certification

System Design



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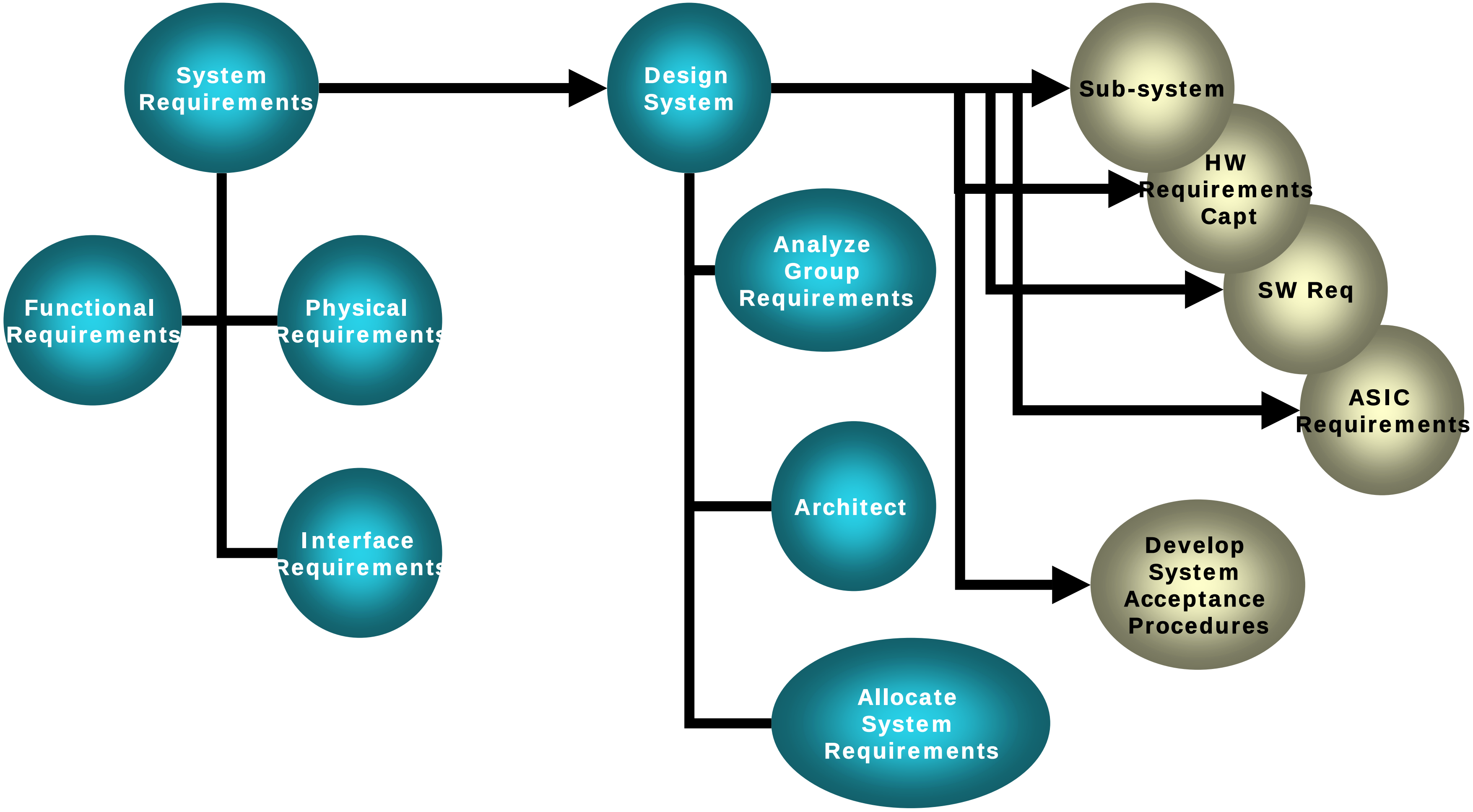
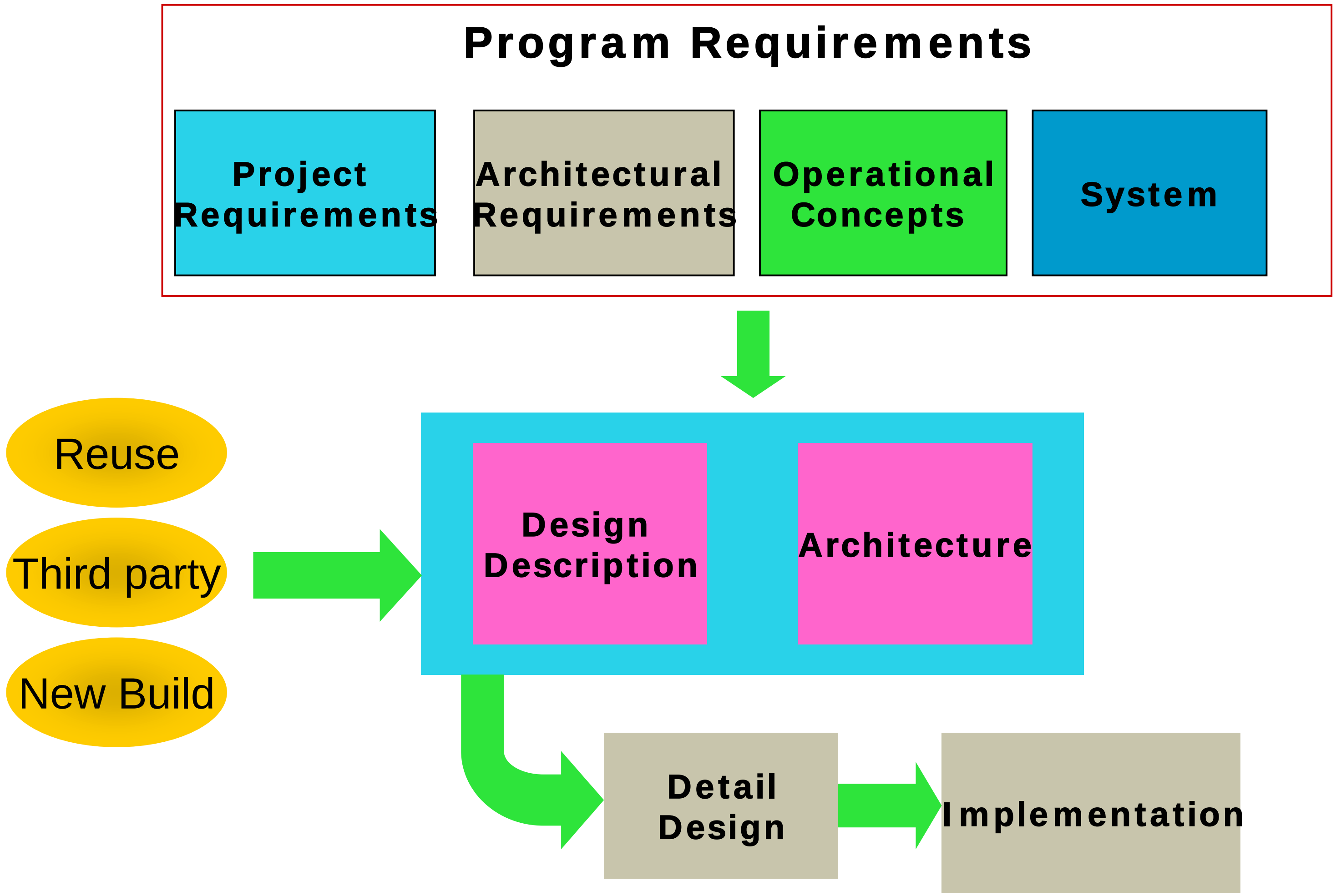
Technical Consistent Process(TCP) Design System



System Development Process



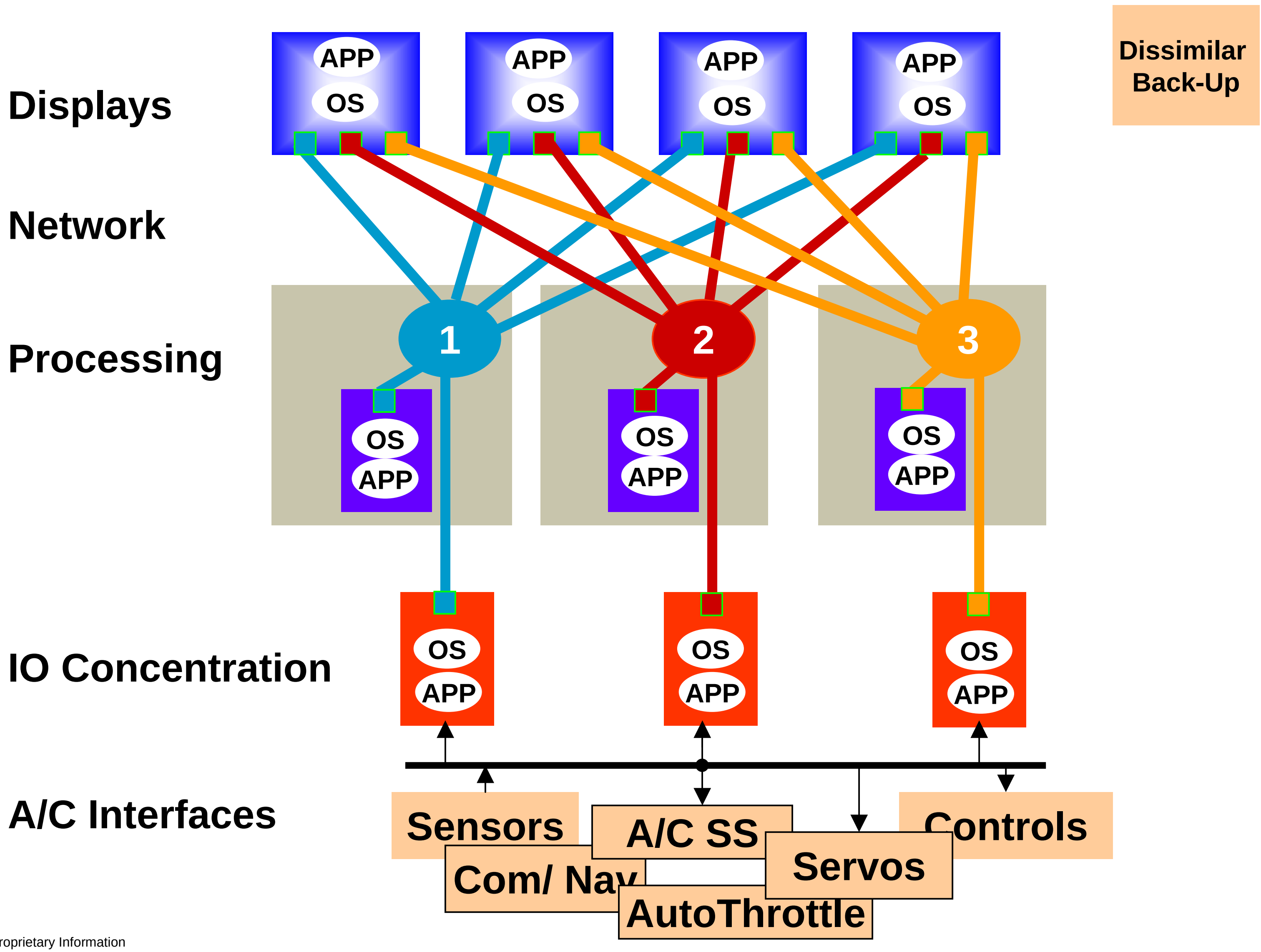
System Design Goals

- Customer requirements
  - Functionality
  - Design for reliability
  - Design for dispatch
- Design for safety
  - Availability
  - Integrity

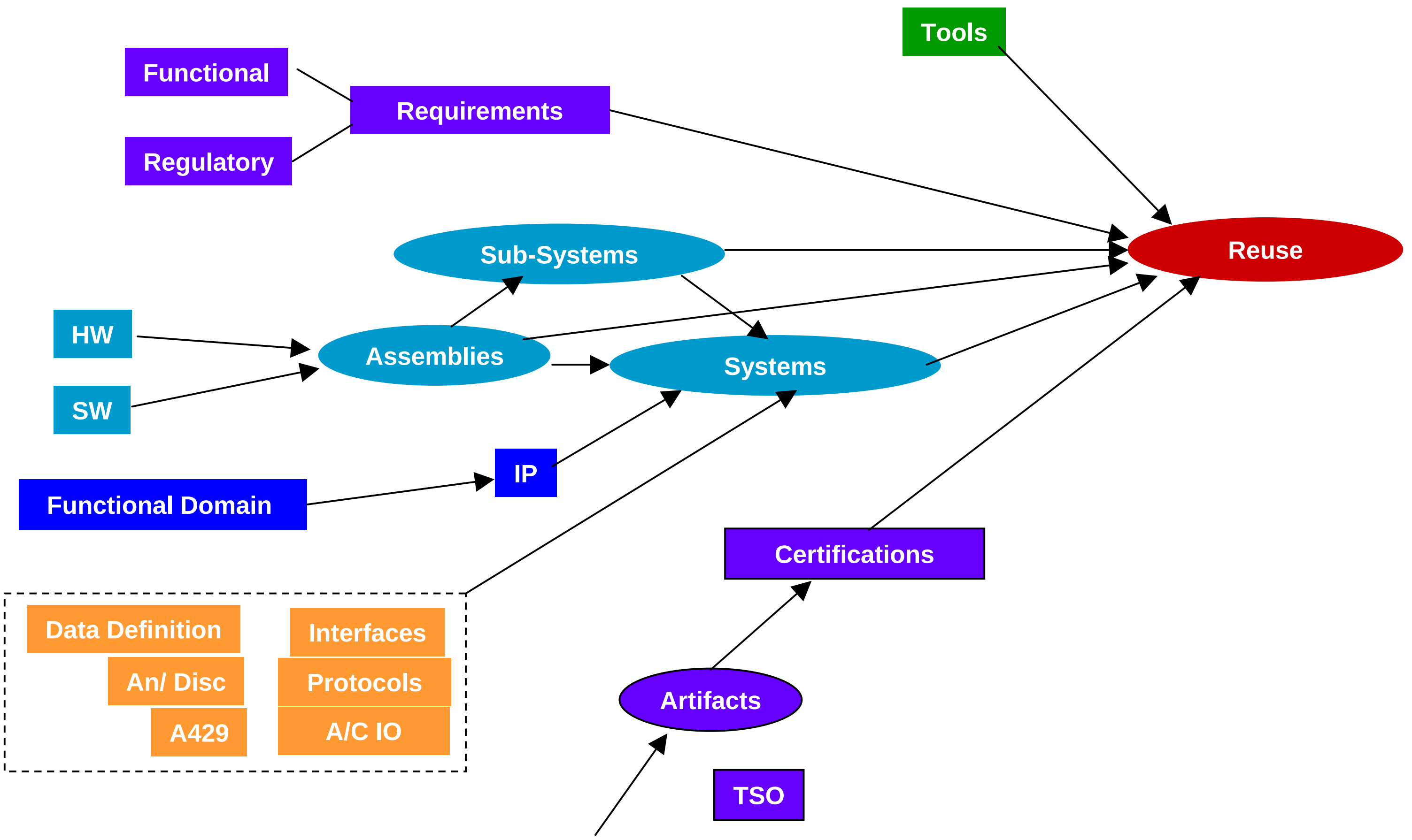
System Design Goals

- Design to minimize:
  - Cost
  - Size, weight and power
- Develop to accommodate change
  - Increased functionality – fly-by-wire / enhanced & synthetic vision
  - Multiple configurations
  - HW obsolescence
- Design for reuse
  - Gather requirements & define the superset
  - Define breakpoints (Interfaces)
  - Plan for Option , Provisions and Growth

Potential Architecture

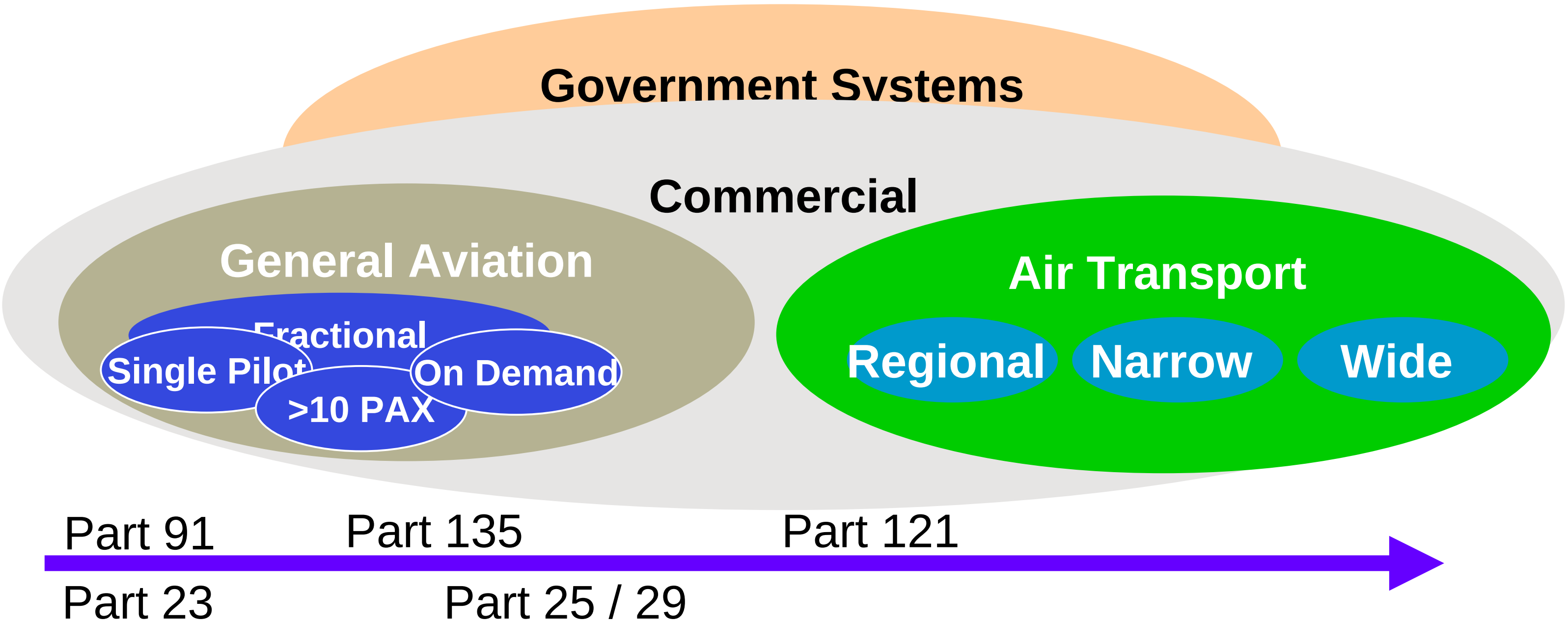


Reuse



Tools
Functional
Requirements
Regulatory
Sub-Systems
Reuse
HW
Assemblies
Systems
SW
IP
Functional Domain
Certifications
Data Definition
Interfaces
An/ Disc
Protocols
A429
A/C IO
Artifacts
TSO

Markets



IMA Product Line developed for the Smaller Aircraft would Scale-up well.

The cost of System development tends to be prohibitive targeted to that market. Especially when existing systems offer sufficient levels of functionality.

Reuse of IMA developed for higher end airplanes difficult in terms of Cost , Size Weight and Power

Air Transport has the Potential for Reuse of IMA Product Line.

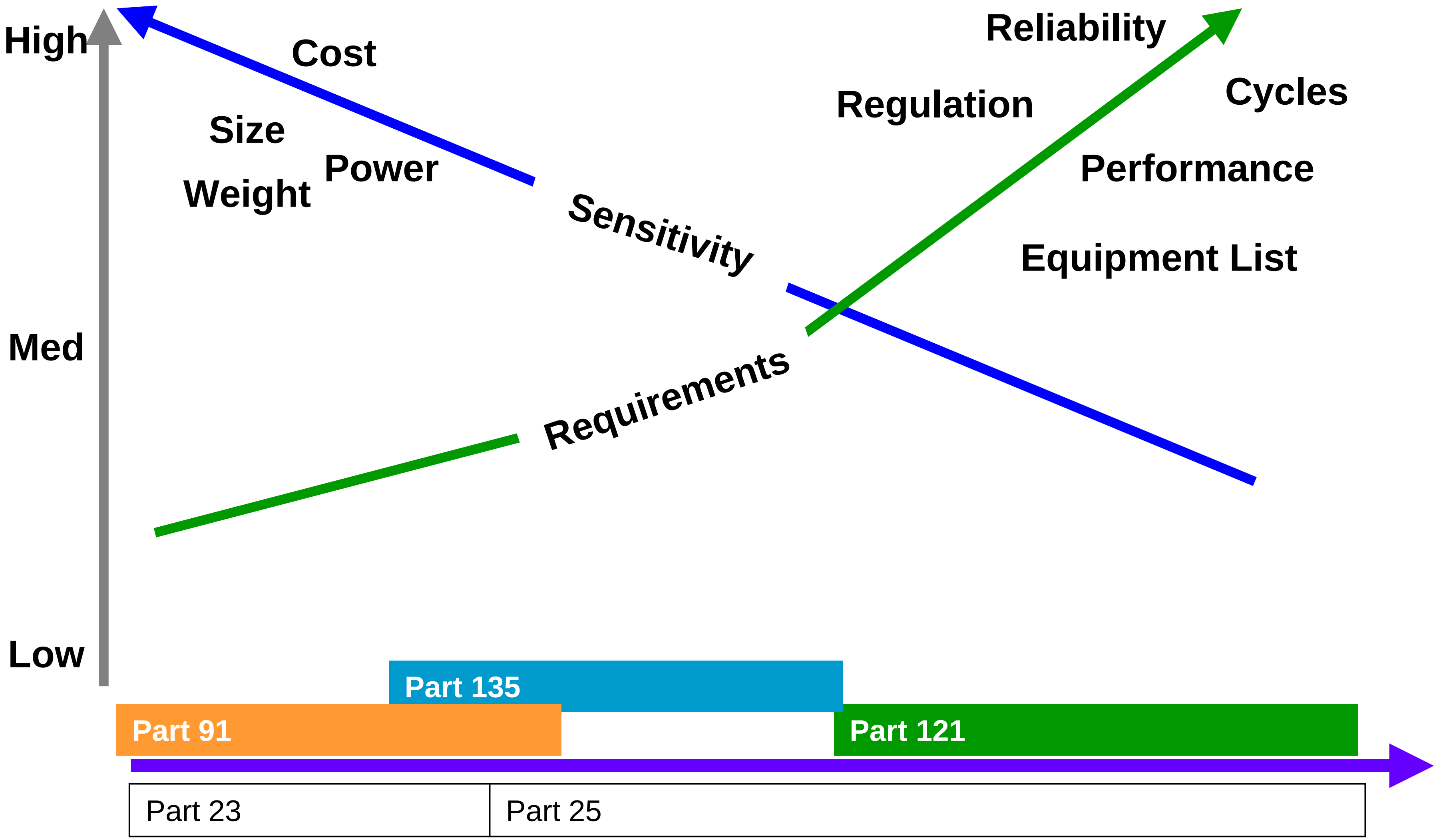
HW Specifications have a High degree of Design Dictated by the Customer Typically Results In A Product That Product Lines Can’t Reuse Widely.

Cost Benefit Improves with Reuse

Functionality

- The differences between Regional Jets and Air Transport airplanes has all but closed. A few standouts like Cat III, Fly-by-Wire but even these are narrowing
  - Regional Jets want to be more like Narrow bodies and Narrow bodies want to be more like Regional Jets
- In General Aviation Functionality between Part 23 and Part 25 has closed
  - Light Jets Blur the Line between weight classes and the Part 135 Light jets Look the same as traditional Part 25 Aircraft

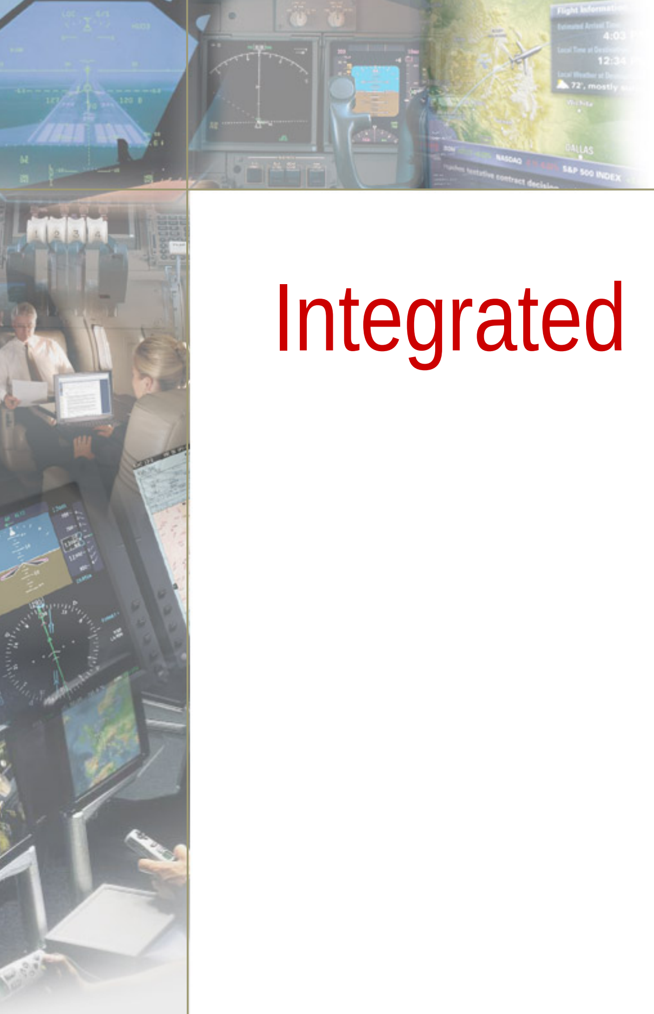
Requirements Vary



Reuse of IMA in Context

- The Reuse of IMA is easier if it has enough constraints:

- Can be Reused on Similar Project
  - Specified At the Aircraft Level or at a Group of Functions
- Product Line Targeted to a
  - Common Family
  - Similar Type or Class
- Reuse is more difficult with mixed customer base



Integrated Modular Avionics

IMA Program Experience

- USAF KC-135
- Boeing 787
- Airbus A380
- Challenger
- ARJ21
- Integrated Flight Information System
- Bombardier Global 5000 Cabin Entertainment System
- SC-200
- Other Programs

Contemporary Integrated Systems

- ARINC 429 Based
- Systems use domain specific hardware.
  - At the board level there was a fair amount of similarity
- The system have much the same footprint:
  - Cabinet based functionality
  - Shared IO HW/ SW
  - The LRMs were packaged to fit into a common form factor and shared IO concentration where possible
- Each sub-system is designed to communicate across an agreed interface
- Sub-systems were brought together and tested as an integrated environment
- A mature system, component or sub-system is re-applied from program to program

IMA Characteristics

- Share system resources
  - To minimize the material overhead to support the system.
- Common HW

  Advantages for common parts - simpler to build fewer things
- Common SW between projects/ markets.
  - Functions (EFIS, EICAS, FMS) tend to evolve gradually from program to program
  - Portability between markets
  - Increased number of projects participating in that evolution shares the cost of development
  - Shares the impact of HW evolution between each generation of avionics system

So What’s Changed?

- Steep learning curve
  - Depth of knowledge has to increase in the systems organization
    - Much more complicated
- Standardization – new standards
  - ARINC 653/ 661/ 664
  - ARP4754
  - RTCA SC-200
- Applications can share HW and SW resources
  - Necessitated
    - Higher degree of complexity
    - Broader system integration task
    - Robustly Partitioned operating system
    - Higher processing capability
    - Common communications

So What's Changed?

- Functions are not associated with a traditionally accepted LRU
  - Impacts TSO Functional groupings
- Common development environment for sub-systems
- "Open" architecture
  - Potential for higher degree of SW portability
  - Typically carry higher SW and HW integrity (superset) requirements
- Higher degree of project management required
  - Initially less insight into the progress being made
    - Tighter tracking via milestones and metrics not a great replacement for technical knowledge

IMA Coping Strategies

- Strong Leadership Team
- Emphasis on system level
- Requirement capture tools – DOORS™ / SLATE™
- Forecast/ choose standards
  - Define communication methods
  - Implement protocol guidelines
  - Implement SW guidelines
- Create user guides
  - Standards minimize the number of different solutions that have to be developed
- Develop benchmarks
- Prototype
- Do everything as early as possible

IMA Pros and Cons

- Pros:
  - Potentially Fewer Different Parts
  - Generally Higher Quality Design for what previously had a lower design requirement
  - Software Portability
  - HW Independence
  - Potentially Easier for HW Reuse
  - Spiral Development – Potentially larger pool of users - Each program adds a little more
- Cons:
  - Certification Authorities Are Very Nervous about IMA
    - Certification Process Changed??
  - More Complex Integration for Avionics Supplier
  - More Complex Interfaces
    - SW Interfaces
    - Logical Routing
    - Complex Throughput Limitations
  - Higher Development Costs
    - Large Concurrent Development
    - Health Monitoring
    - OS Development
    - Network
    - HW
    - Porting Apps
  - Resource Intensive
    - Large Demand for High Caliber Engineering Team

Responsibilities For the Long Haul

- In an IMA system, the system integrator will have a much tougher time. They are the owner and orchestrator of all current and future applications on the airplane.
- Contractual areas of responsibility need to be well thought through in advance
- Problems encountered when a new player comes along and has to be managed.
  - Expect more finger pointing.
  - Good tools and protocol standards need to be agreed
- Certification needs to be well planned

Certification

IMA Approval plans

SC-200

Current State

Future IMA Approval Plans

- Participating in SC200 and Regulatory Processes for IMA Approval Guidance
- Reuse of Hardware and Software Development Artifacts from ARJ21, B787 and A380
- FAA Engage Program Using PSP PSCP Process for IMA Based Virtual Aircraft Installation Provides a Means to Establish Future IMA Certification Approach
- Expected IMA Approach and Benefits
  - Incremental Credit Available at Each Tier of Integration Allows “Certification Credit” for Testing Off the Aircraft
  - Each Module in the IMA can be Qualified to the Granularity that Makes Sense for the Project
  - IMA Platform Recognized can be a Qualified Entity: The Whole Cabinet, or a Single LRM (Rockwell Collins Term)
  - Reuse of Module Approvals Between Airplane Programs
  - Recognized Industry Standard

Concerns About Implementation of SC-200

- Will the guidance be adopted?
- Bang for the buck
  - Higher level of expense to document system
  - Letter of Credit – How does it work?

    Longer Lead times to get approvals?

    Differences between ACO interpretation?

    Differences between International interpretation?

    Difficulty in Sequential and Concurrent Developments

    Don’t want to wait for one program to certify

  - Certification Credit For Testing Off The Aircraft

SC-200

- Pros:
  - Provides an end to end process to certify a system
  - Alludes to cert credit between projects
  - Flexible requirement definition
    - You define it
    - You verify it
- Cons:
  - Requires change in processes to make available more levels requirements and validation
  - Leads to higher degree of formality for what were internal processes
  - Change of emphasis to the Avionics Vendor

General Approach

- Employ Existing Regulatory Processes While IMA Guidance Matures
- Be Cognizant of and Influence Domestic and Foreign Regulatory and Guidance Policy
  - Individual Decision Maker / Influencers
- Engage Regulators on a Virtual Certification Program
- Be Aware of Certification Issues and Lessons Learned from Previous Programs Employing IMA

Integrated Processing System TSO Approach

- ARJ21 Integrated Avionics System
  - IPS-5000 Employs Traditional Functional TSOs for Approval Plan
  - FAA Project Number SP4253WI-Q Applies
- Traditional TSO Application Based on Individual “Subsystems”
  - Problems for Applicants Attempting to Use C153
  - Additional Documentation Required (SC-200)
  - FAA and Customer Unfamiliarity Seen as Risk
- Hardware Only modules, No Hosted Software, Approved to TSO Superset as Common to Multiple Functions
- Hardware Computing Modules TSOs include Factory Loaded System Software / Tables for Module Dataload
  - Approved to TSO Superset as They Support Multiple Functions
- Application TSOs Monolithic Loadsets Include Field Loaded System Software and Configuration Tables to Use TSOs to Reflect Specific Content
- A Change to a Loadset Will Require Resubmittal for Any Affected Subsystem TSO
  - Reusable Software Artifacts are Created for Individual Applications / VMs
  - Largely a Paperwork Exercise for Any Unchanged VMs

IPS-6000 TSO Approach

- Application of TSO C153 Becoming More Widespread
  - B-787 CCS and Hosted Modules
    - Including RCI Supplied ARINC 664 AFDX Switch
- Expect to Employ TSO 153 for Hardware Modules
  - Would Allow Reuse of Platform Hardware Approval Across Aircraft Types
  - Application TSOs Monolithic Loadsets to Use TSOs to Reflect Specific Content
  - Fall Back Plan as ARJ21
- Individual Module Loadsets Integrated into One Top Level Software Product for Entire IPC
  - Simplify OEM Ordering
  - Part 21 Electronic Part Marking Done at Top Level for All Software in Cabinet
- Other Configuration Files and Database Files are Not TSO’d Due to Airplane Specific Nature or Update Cycle
  - Maintenance Equations, FMS Performance Database
    - Approved as Part of Airplane
  - FMS Navigation Database, Charts
    - Database Control Processes (e.g. DO-200A)

Thank You